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949,018

PATENT SPECIFICATION

DRAWINGS ATTACHED

Inventors: HERMANN STRAUB and SIEGFRIED KRAUSS

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COMPLETE SPECIFICATION

Improvements in or relating to Driving Machines, e.g. Electric Motors, having Electromagnetically Operated Disc or Cone Brakes

We, ZAHNRADFABRIK FRIEDRICHSHAFEN AKTIENGESELLSCHAFT, of Friedrichshafen-on-the-Bodensee, Germany, a Joint-Stock Company incorporated under German Law, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a driving machine having an electromagnetically operated disc or cone brake connected to its driven members for stopping the driving machine.

Various constructions of electric motors having electro-magnetically operated multi-disc or cone brakes and which are used as brake motors are already known. The braking members in these arrangements are frequently flanged on to the end face of the motor casing remote from the driving side and brake the motor output shaft when required. Brake motors of this type are used in many branches of industry, particularly in machine tool construction. The present invention aims at improving the construction of these known machines and to this end consists in a driving machine, particularly an electric motor, having an electromagnetically operated disc or cone brake connected to the output shaft for stopping the driving machine, wherein rolling bodies each rotatable about its axis are arranged between the co-operating friction surfaces of the brake discs or cones, said rolling bodies being guided by means of a cage or by a suitable shaping of the friction surfaces of the brake discs or cones, for rotation about their axes and against displacement therealong.

The friction surfaces in this arrangement can be in the form of plane surfaces lying in parallel planes to one another or as conical surfaces running at least approximately parallel to one another, or else one of the mutually associated friction surfaces can be in the form of a plane surface or cylinder surface and the co-acting surface in the form of a conical surface.

The rolling bodies may be disposed with their axes of rotation extending radially in relation to the brake axis or directed at least approximately parallel to one another, or else the axes of rotation can extend at identical angles other than 90° with respect to the direction of movement of the revolving brake parts. The rolling bodies themselves may be constructed as cylindrical rollers, as bodies of revolution having a conical outer surface or they may be barrel-shaped.

A driving machine constructed according to the invention can be used with particular advantage in machine tools for the purpose of shortening or in certain circumstances entirely eliminating idle periods by rapidly stopping the machine plant. The frictional engagement between the friction surfaces and the rolling bodies can in fact be built up and interrupted very quickly in the construction proposed. The rolling bodies rotatable about an axis and disposed between the friction surfaces perform a partly rolling and partly sliding movement during the braking operation because of the different paths which they have to travel or because of the inclination of their axes of rotation relation to the direction of movement of the revolving structural parts. The frictional force thus transmitted is substantially dependent on the pressure force acting on the friction surfaces and

[*Price*

the rolling bodies, so that by bringing this pressure force into or out of action the braking moment can be effective and thus the driving machine braked within a very short space of time.

Morever, such a driving machine is also suitable for drives in which gentle and smooth braking is required particularly for heavy fly masses. Through the arrangement of the rolling bodies between the friction surfaces the loadability of the present friction brake as compared with constructions used hitherto is in fact substantially increased, since the amount of heat produced during braking can be removed without difficulty. During the frictional engagement the friction surfaces no longer lie against one another but merely make contact with a part of the surfaces of the rolling bodies so that a coolant can flow through almost unhindered between the friction surfaces under all operating conditions, that is to say also during braking.

In order to obtain particularly good cooling of the friction surfaces, it is proposed according to a feature of the invention to allocate to the brake a fan which can be driven in dependence on the output speed of the driving machine, for example the part of the output shaft carrying the friction brake. Furthermore, the fan may be provided with a freewheel device which becomes effective during the braking of the driving machine. In this case the fan is not braked together with the driving machine but because of the kinetic energy supplied to it previously, it runs down slowly so that no thermal peaks can occur.

In order that the invention may be more readily understood, reference is made to the accompanying drawings which illustrate diagrammatically and by way of example several embodiments thereof, and in which:—

Figure 1 shows part of a multi-disc friction brake attached to an electric motor and having rolling bodies disposed between the discs in a longitudinal section,

Figure 2 shows part of a cage for guiding the rolling bodies, in elevation,

Figure 3 is a similar view to that of Figure 1 of a cone brake,

Figure 4 shows part of a cage having rolling bodies disposed centrally radially, and

Figure 5 shows part of a cage having rolling bodies aligned parallel to one another.

In Figure 1, a brake body 7 and a fan 10 are mounted fast on the shaft 2 of an electric motor 1 by means of a key 11 and are secured against axial displacement by circlips 12, 13. The brake body 7 which is provided with splines 8 for the inner friction discs 20 carries an abutment 19 for the discs and supports an annular magnet body 5 which is secured to the brake casing 4 and between the flanges of which the magnet coil 6 is disposed. The two-piece brake casing 4 which is joined fast to the cooling ribs 3 of the electric motor 1 is in addition provided with splines 15 for the armature disc 16 and the outer friction discs 21.

Cages 22 formed with cavities or recesses 26 for receiving the rolling bodies 23 are disposed between the inner discs 20 and the outer discs 21. The rotational axes 27 of the rolling bodies 23 are inclined at the angle α in relation to the direction of movement 28 of the rotating structural parts of the brake.

The multi-disc friction brake illustrated in Figure 1 operates in accordance with the closed-circuit principle, that is to say when the electric motor 1 is switched on the magnet coil 6 is also simultaneously energised. A magnetic field running in accordance with the chain-dotted line 25 is thus produced so that the armature disc 16 is pulled to the magnet body 5 against the force of compression springs 17 and the motor shaft 2 can thus turn freely.

When the electric motor 1 is switched off the energising current of the magnet coil 6 is also switched off so that by means of the springs 17 the inner and outer friction discs 20, 21 are pressed against the rolling bodies 23. The inner discs 20 which are connected to the motor shaft 2 thus set the rolling bodies 23 which are guided by the cages 22 in motion, so that these bodies roll on the outer discs 21. In consequence of the inclined position of the rolling bodies 23 in relation to the direction of movement 28 of the cages 22, they do not however perform a purely rolling movement but they also slide at the same time along the stationary outer discs 21. The frictional force produced by this sliding movement has the effect that the inner friction discs 20 and hence the shaft 2 of the electric motor 1 are braked.

The fan 10 mounted fast on the shaft 2 of the electric motor 1 sucks cooling air through the openings 24 and 9 disposed respectively in the casing 4 and in the brake body 7, when the electric motor 1 is running, this air passing between the discs 20, 21 and the rolling bodies 23 and being delivered to the cooling ribs 3. The heat produced at the friction surfaces of the brake and in the electric motor 1 is thus removed. A seal 18 arranged between the brake body 7 and the magnet body 5 prevents the cooling air from flowing through between the armature disc 16 and the magnet body 5.

The fan 10 is also provided with a freewheel device 14 of known type, details of which are not illustrated. This freewheel device 14 is advantageously so constructed that by virtue of the kinematic energy supplied to the fan 10 during running of the motor 1, the fan can run out slowly during the braking of the shaft 2. In this way it is possible to remove satisfactorily the heat

generated at the disc friction surfaces and the rolling bodies during the braking of the fly masses, so that no thermal peaks can occur.

Figure 3 illustrates a further embodiment of an electromagnetically operated brake attached to an electric motor 31 and having friction surfaces inclined at an angle to the axis of the motor. The annular magnet body 40 of U-shaped cross-section which carries the magnet coil 41 is here joined fast by means of a sleeve 39, supported by needle bearings 38 on the motor shaft 32, to the bridge 35 of the brake casing 34. A brake body 45 and a fan 46 are mounted on the motor shaft 32 to be non-rotatable and axially non-slidable thereon. The armature 42 guided by splines 47 on the sleeve 39 is provided with an arm 44 the end of which is constructed as a friction surface inclined at an angle to the axis of the shaft 32 and is disposed opposite the correspondingly constructed end portion of the brake body 45. For the purpose of producing the frictional engagement between the brake body 45 and the armature 42 there are disposed between the mutually facing friction surfaces thereof rolling bodies 49 which are rotatable about their axes and which are guided rotatably and non-slidably in recesses formed or provided in the friction surfaces.

Unlike the embodiment illustrated in Figure 1, the brake illustrated in Figure 3 operates on the open-circuit principle, that is to say when the electric motor 31 is switched off, voltage is at the same time applied to the magnet coil 41 so that a magnetic field running along the chain-dotted line shown in the drawing is produced. An insulating plate 50 provided on the magnet body 40 prevents the magnetic lines of force from passing over into the arm 44 of the armature 42. Through the magnetic force produced by the coil 41 the armature 42 is drawn to the magnet body 40 so that the friction surfaces of the armature arm 44 and of the brake body 45 joined to the shaft 32 are pressed against the rolling bodies 49 and the motor shaft 32 is braked.

During operation of the motor 31 the fan 46 sucks cooling air through the apertures 37 and 48 provided respectively in the casing 34 and in the brake body 45 and delivers it through apertures 36 in the bridge 35 to the cooling ribs 33 of the electric motor 31. The heat generated at the friction surfaces is at the same time also removed by the cooling air.

The brake illustrated in Figure 3 can preferably be used as a holding brake, since even when the electric motor 31 is not running the excitation current of the magnet coil 41 can be switched on. The braking action can be interrupted at any time by disconnecting this circuit.

Figures 4 and 5 show other forms of construction of the cages for guiding the rolling bodies. In Figure 4 the rolling bodies 63 inserted in the cavities 62 in the cage 61 are disposed with their axes of rotation 64 directed centrally radially, while in Figure 5 the axes of rotation 74 of the rolling bodies 73 which are barrel-shaped and similarly inserted in cavities 72 in the cage 71 and rotatably and non-slidably guided by the said cage, are directed parallel to one another.

WHAT WE CLAIM IS:—

1. A driving machine, particularly an electric motor, having an electromagnetically operated disc or cone brake connected to the output shaft for stopping the driving machine, wherein rolling bodies each rotatable about its axis are arranged between the co-operating friction surfaces of the brake discs or cones, said rolling bodies being guided by means of a cage or by a suitable shaping of the friction surfaces of the brake discs or cones, for rotation about their axes and against displacement therealong.

2. A driving machine as claimed in claim 1, wherein the friction surfaces are provided with recesses for guiding the rolling bodies.

3. A driving machine as claimed in claim 1, wherein the friction surfaces are constructed as plane surfaces lying in parallel planes which are disposed at right angles to the brake axis.

4. A driving machine as claimed in claim 1, wherein the friction surfaces are inclined at an angle to the brake axis, and lie at least approximately parallel to one another.

5. A driving machine as claimed in claim 1, wherein one of the co-operating friction surfaces is constructed as a plane end face or a cylindrical surface and the other surface as a conical surface.

6. A driving machine as claimed in any of the preceding claims, wherein the rolling bodies are so disposed that their axes of rotation extend radially in relation to the brake axis.

7. A driving machine as claimed in any of claims 1 to 5, wherein the rolling bodies are so disposed that their axes of rotation extend at identical angles other than 90° with respect to the direction of movement of the revolving brake parts.

8. A driving machine as claimed in any of claims 1 to 5, wherein the rolling bodies are so disposed that their axes of rotation extend at least approximately parallel to one another.

9. A driving machine as claimed in any of the preceding claims, wherein the rolling bodies are constituted by cylindrical rollers.

10. A driving machine as claimed in any of claims 1 to 8, wherein the rolling bodies are constituted by barrel-shaped rollers.

11. A driving machine as claimed in any of the preceding claims, including a fan associated with the brake for supplying a coolant

to the friction surfaces, said fan being adapted to be driven in dependence on the output speed of the driving machine.

12. A driving machine as claimed in claim 11, wherein air is used as coolant.

13. A driving machine as claimed in claim 11 or 12, wherein the fan is adapted to be driven by the portion of the output shaft of the machine carrying the friction brake.

14. A driving machine as claimed in any of claims 11 to 13, wherein the fan is provided with a freewheel device coming into action on the braking of the driving machine.

15. A driving machine as claimed in any of the preceding claims, wherein the rolling bodies are arranged in such a manner as to facilitate passage of the coolant.

16. A driving machine as claimed in any of claims 11 to 15, wherein the fan and the friction brake are combined to form a structural unit and are preferably disposed in a common casing provided with apertures for supplying the current of coolant.

17. A driving machine, particularly an electric motor, having an electromagnetically operated disc or cone brake connected to the output shaft, substantially as herein described with reference to Figures 1 and 2 or Figure 3 or Fig. 3 as modified by Figs. 4 or 5 of the accompanying drawings.

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949018 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction o the Original on a reduced scale*
Sheets 1 & 2

Fig. 1

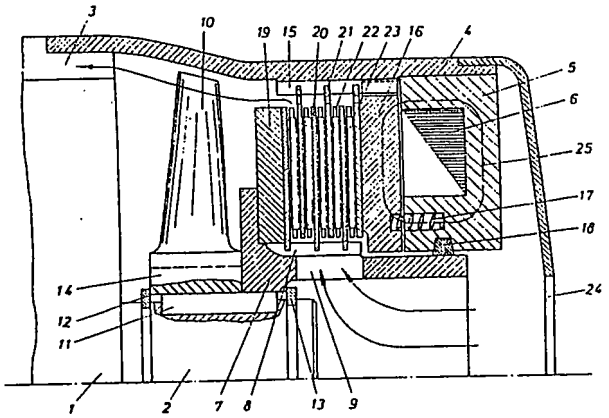

Fig. 3

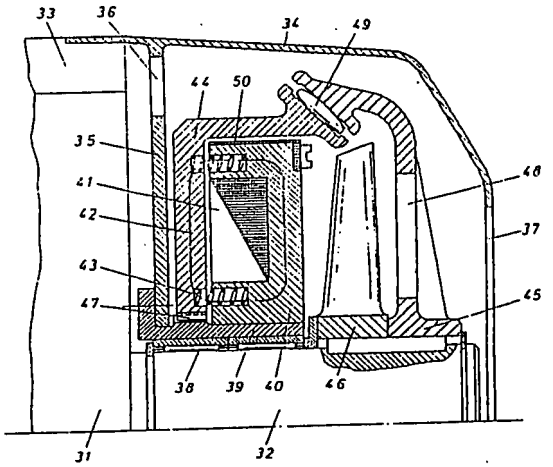

Fig. 2

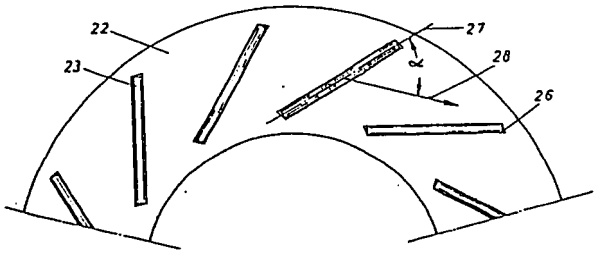

Fig. 4

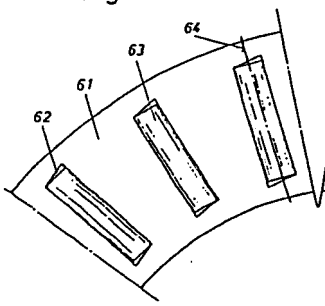

Fig. 5